U.S. AIR FORCE

COMMERCIAL SPACE

An Overview of Private Space Industries and Markets

Presented by SMC/XR

Doug Holker

25 September 2002

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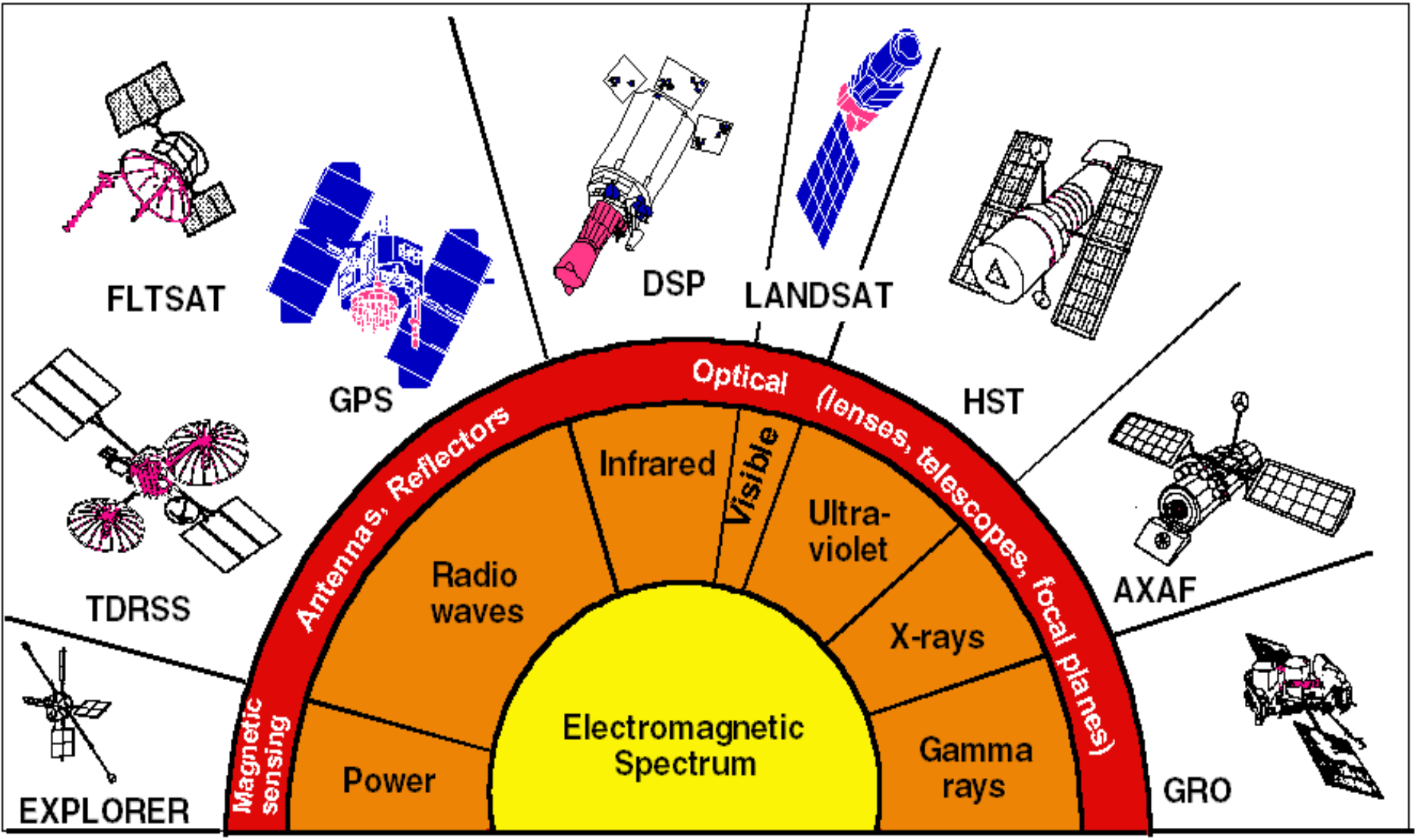
Commercial Space Outline

- Why Commercial Space?
- The Commercial Space Markets/Systems
  - Space Transportation
  - Communications
  - Navigation
  - Remote Sensing
- Commercial Space Opportunities and Challenges
  - Example from Schriever 2001 Space Wargame
- Commercial Video
- Questions

Payloads and the EM Spectrum



- Instruments and assemblies that accomplish the mission
- One spacecraft may have several payloads
- Payload electronics are housed in the body of the spacecraft

Why be Concerned with Commercial Space?

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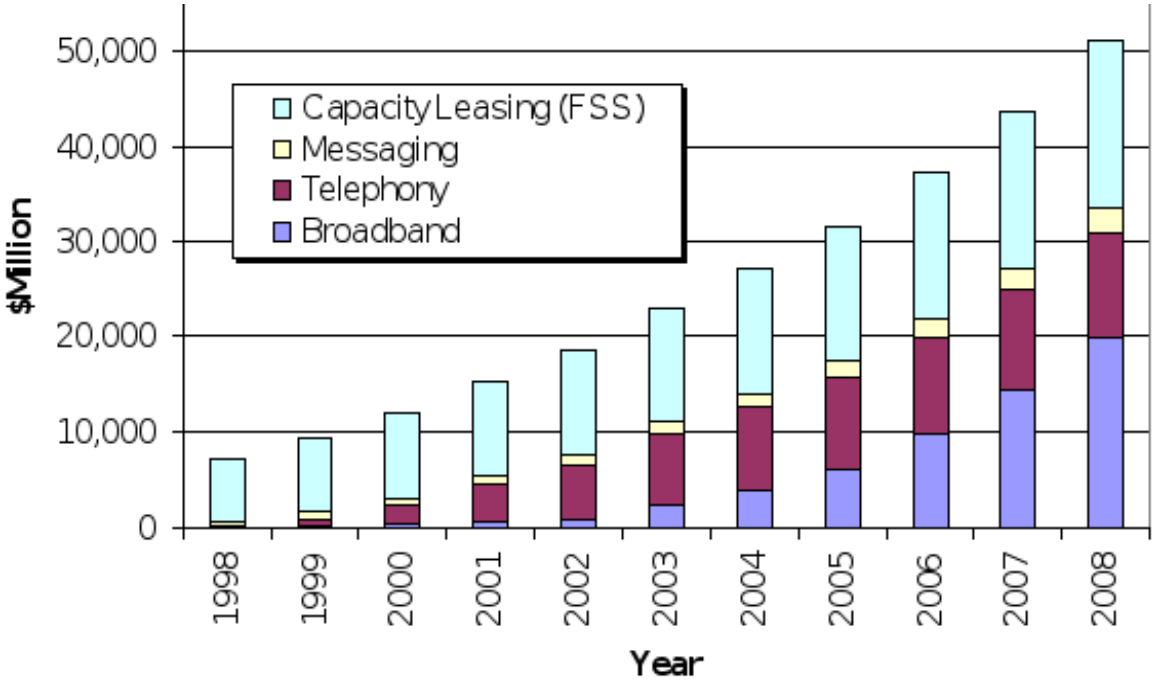
"Leveraging commercial capabilities/investments creates opportunities for a more effective and efficient military capability supporting and stimulating our nation's industrial capabilities."

-LtGen De Kok 5/99

"new technologies that are most critical to our military advantage ... are being driven by fast-growing commercial demand, not by military demand. DoD must get on the shoulders of these dynamic commercial industries to take full advantage of them."

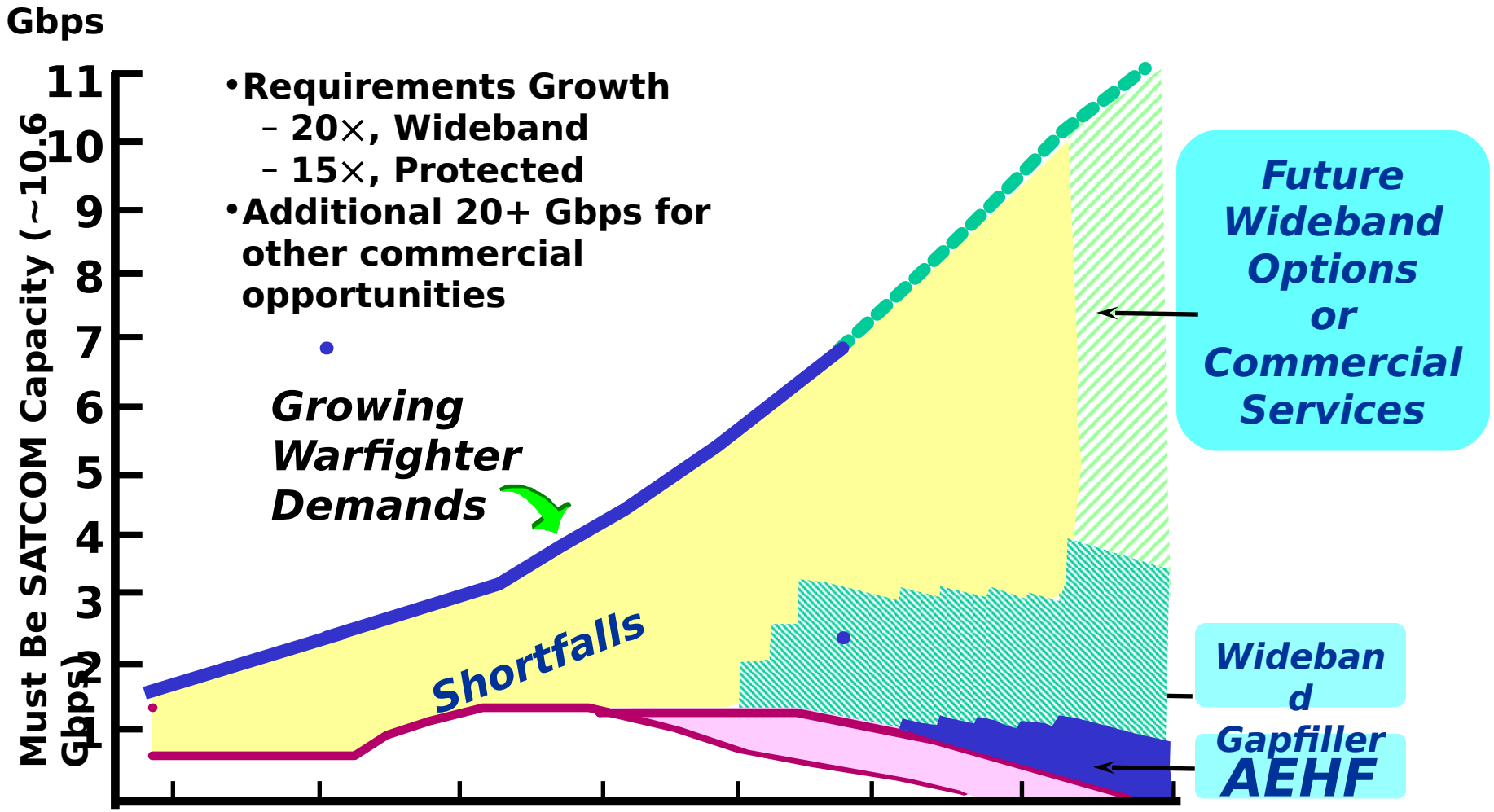
Tremendous Growth in Commercial Space Services is Anticipated Over the Next Decade

Example Commercial SATCOM Revenue Growth



Source: C.E. Unterberg, Towbin

Growing Warfighter Demand for SATCOM Capacity



Navy's demand... Then and Now

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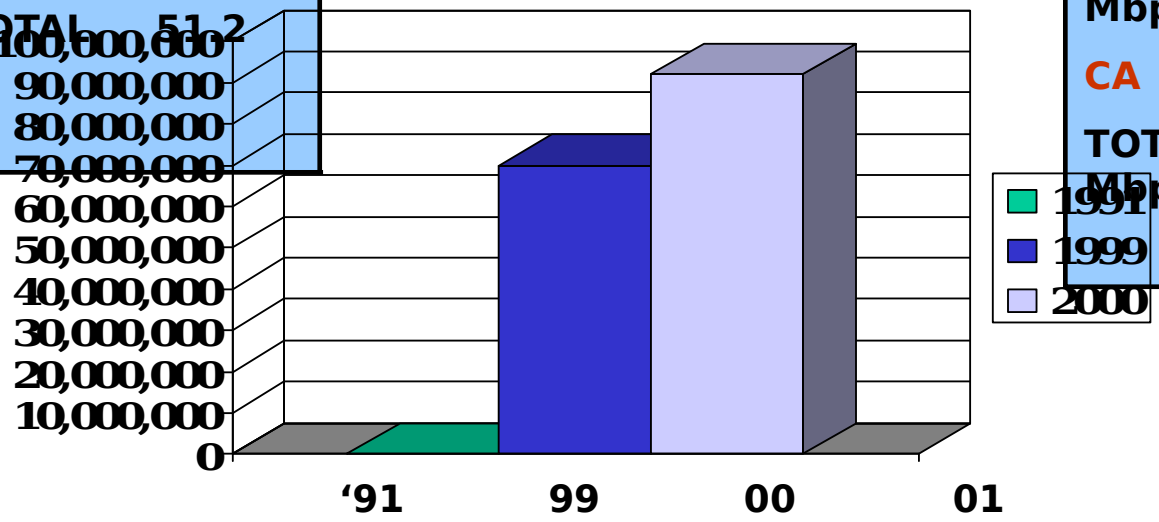
DESERT STORM BANDWIDTH

UHF	19.2 Kbps
SHF	16.0 Kbps
INMARSAT	16.0 Kbps
TOTAL	51.2 Kbps

TODAY'S BANDWIDTH

UHF	.8 Mbps
SHF	42.0 Mbps
INMARSAT	5.2 Mbps
EHF	.5 Mbps
CA	50 Mbps
TOTAL	99.5 Mbps

Desert Storm



Military Uses of Commercial Space

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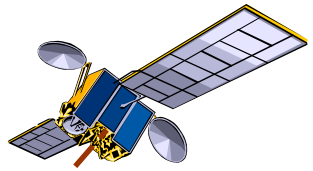
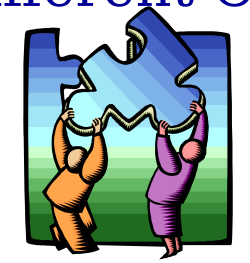
- Reduced Cost through funding allocation

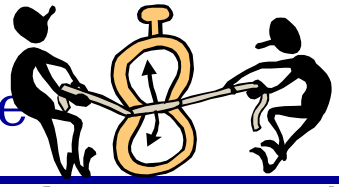


- Augment Capabilities
  - Different Capabilities than military



Blue Force Tracking (BFT)

  - Increased coverage
  - Decreased Time



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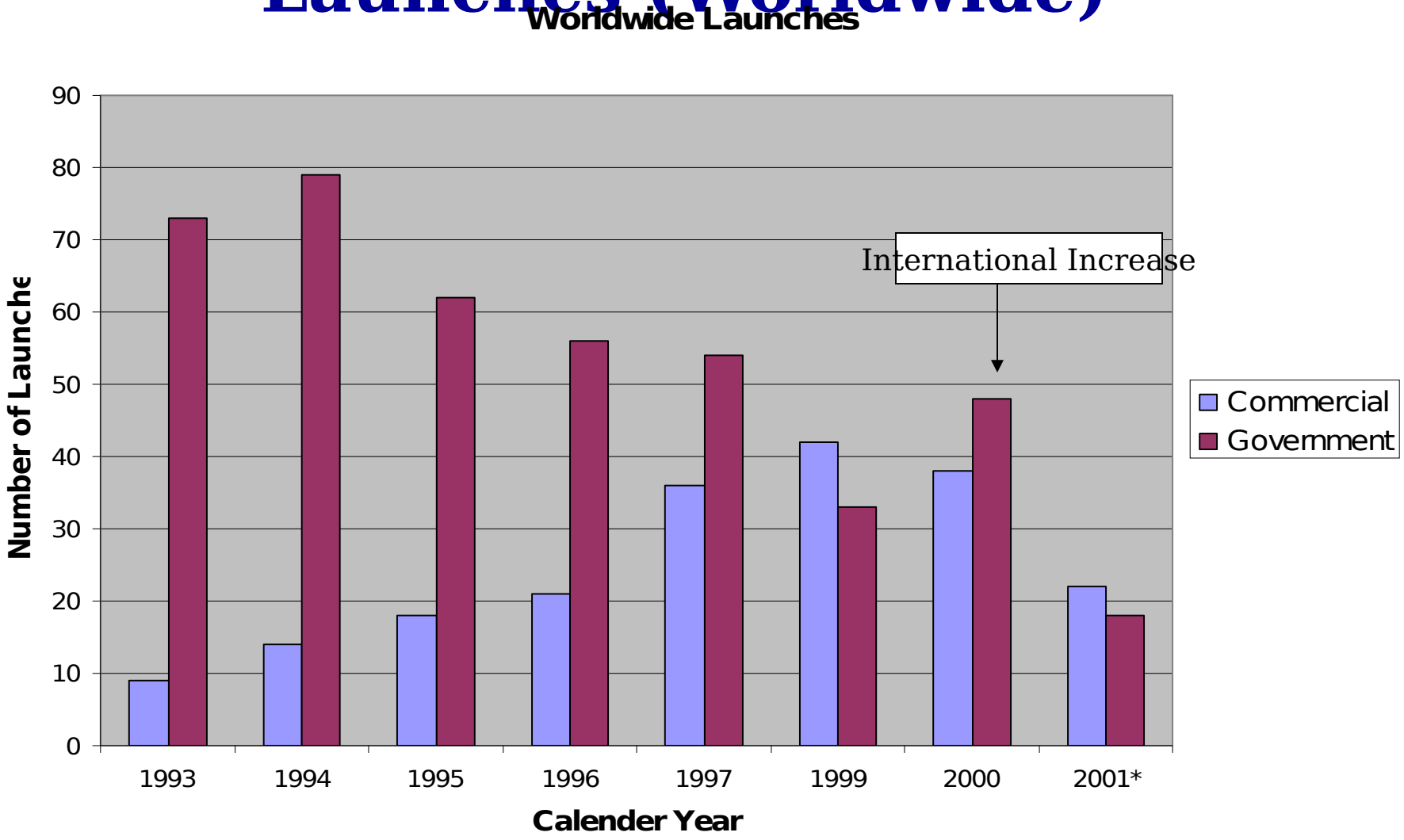
Space Transportation

Delta II

Atlas II

--Pegasus Booster (Orbital Sciences Corp.) also shared by commercial and military customers

Commercial vs. Government Launches (Worldwide)



Composite of LEO Launch Projections

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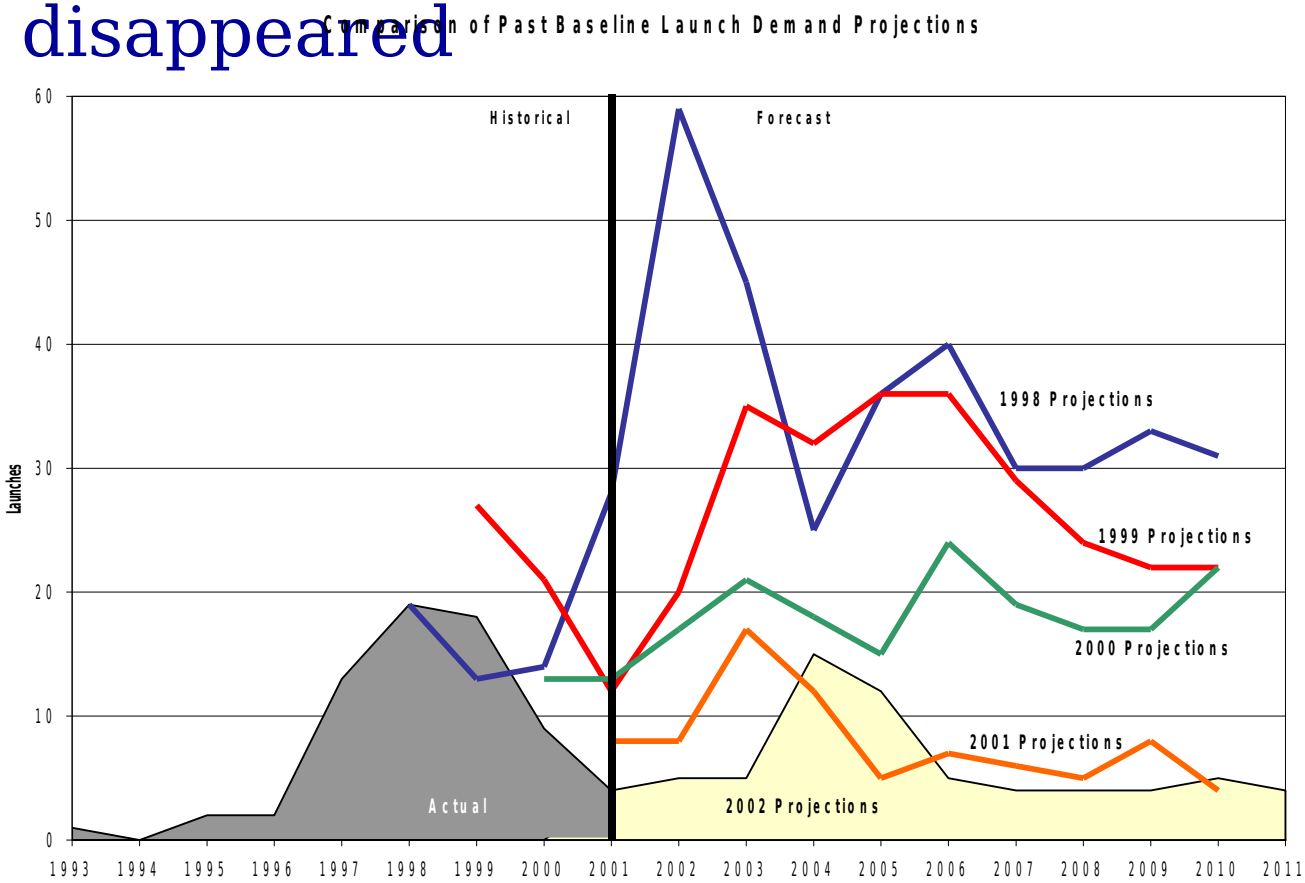
- Launch projections have leveled off
  - Markets of Commercial RLVs have disappeared



Source: FAA May 2002

Planned Low or Medium Earth Orbit Communications Satellite Networks (1997-2005)

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Company	Name	Number	Remarks
Motorola	Celestri	63 satellites	Terminated
Motorola	Iridium	66+4 satellites	Restructured
Motorola	M-Star	72 satellites	Terminated
Loral Qualcomm	GlobalStar	48+4? satellites	Chapter 11
Mobile Comm (MCHI)	Ellipso	16+2 satellites	Terminated
TRW/Teleglobe	Odyssey	12 satellites	Terminated
Constellation Comm	Aries (ECCO)	46+2 satellites	Terminated
GE Americom	Eyetel	24 satellites	Terminated
LEO One Worldwide	LEO One USA	48 satellites	Slipped
Final Analysis	FAlsat	32+6 satellites	Terminated
Teledesic Corp	Teledesic	142? satellites	Slipped
Starsys	Starsys	24 satellites	Terminated
Orbital Sciences	Orbcomm	35 satellites	Chapter 11
CTA	GEMNet	32? satellites	Terminated
Teledesic-ICO Global Holding Co	ICO	10+2 satellites	Restructuring
Alcatel	Skybridge	64 satellites	Terminated
INPE, Telebras, Constel. Com.	Telebras, Brazil	12 satellites	

Commercial Space Transportation Expendable Launch Vehicles

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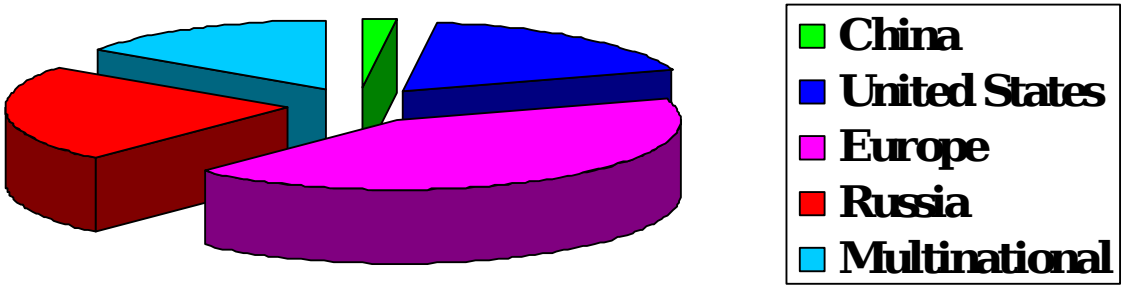
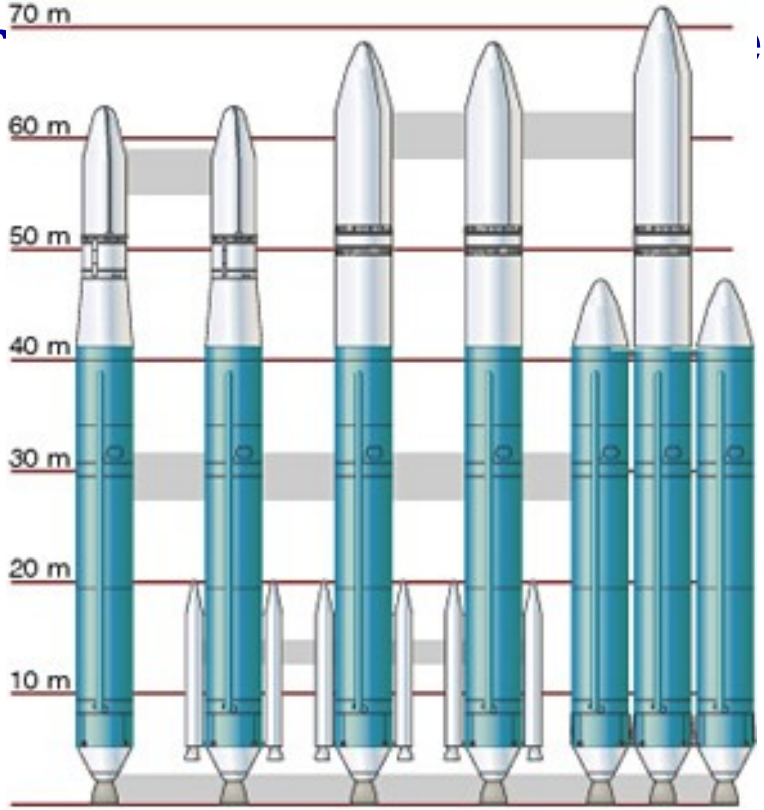
- US systems typically more expensive than competition
  - Primarily developed as ICBM derivatives



- Europe's family of Ariane vehicles currently have largest commercial marketshare
- Russian systems have entered commercial launch arena (Proton and derivatives)

Evolved Expendable Launch Vehicles (EELV)

- Military/Commercial venture with Boeing & Lockheed
  - Such as the Delta II and Titan II
- Next gener launch vehicles



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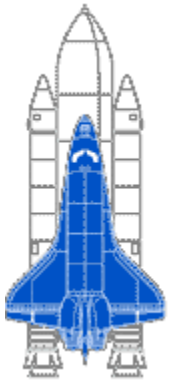
Commercial Space - Reusable Space Transportation Systems

- NASA primary agent as defined by US national policy
- Air Force working with NASA to explore concepts
- Current system - Space Shuttle



- Next Generation Goals
  - Technology demonstrators
  - Validate concepts and reduce industry risk
  - Lead to new system or advocate continued use of space shuttle

Commercial RLV Concepts

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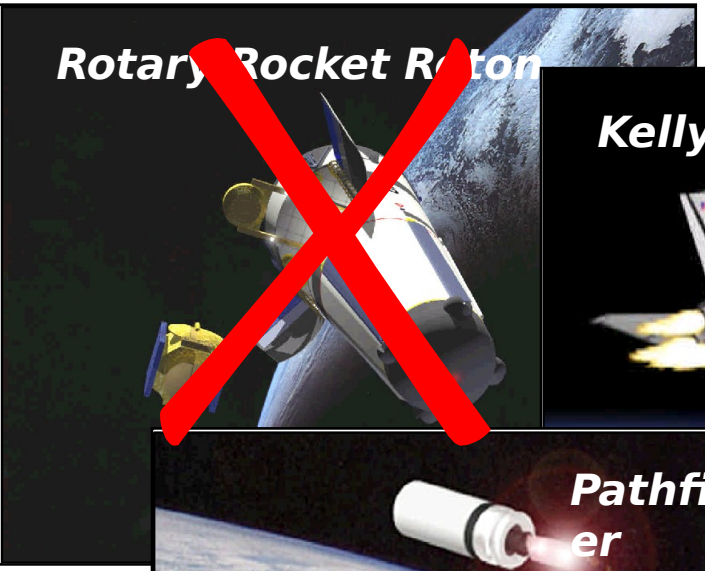

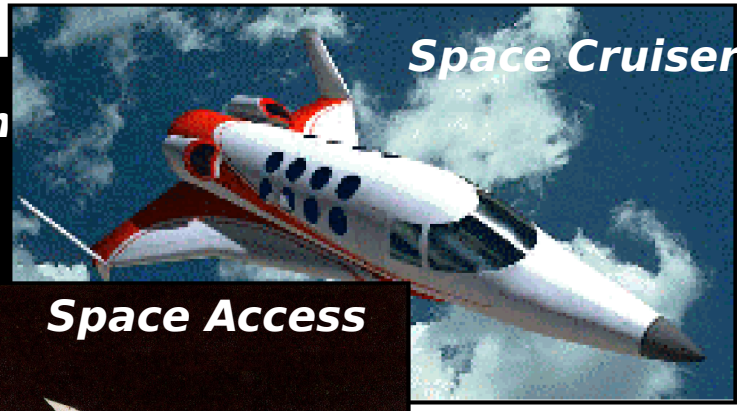

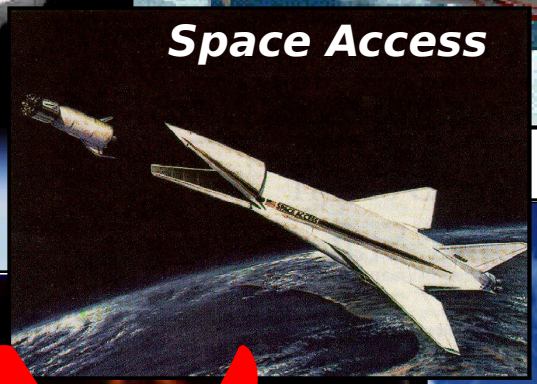

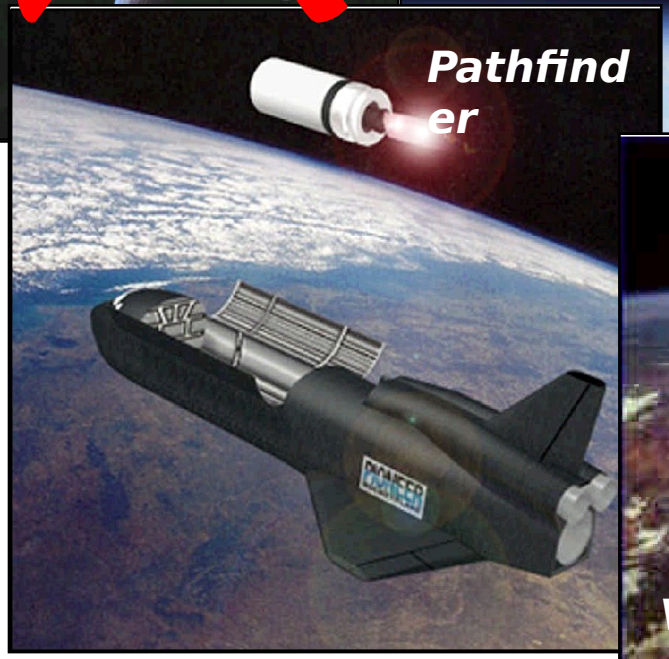

Convergence of Commercial and Military Space

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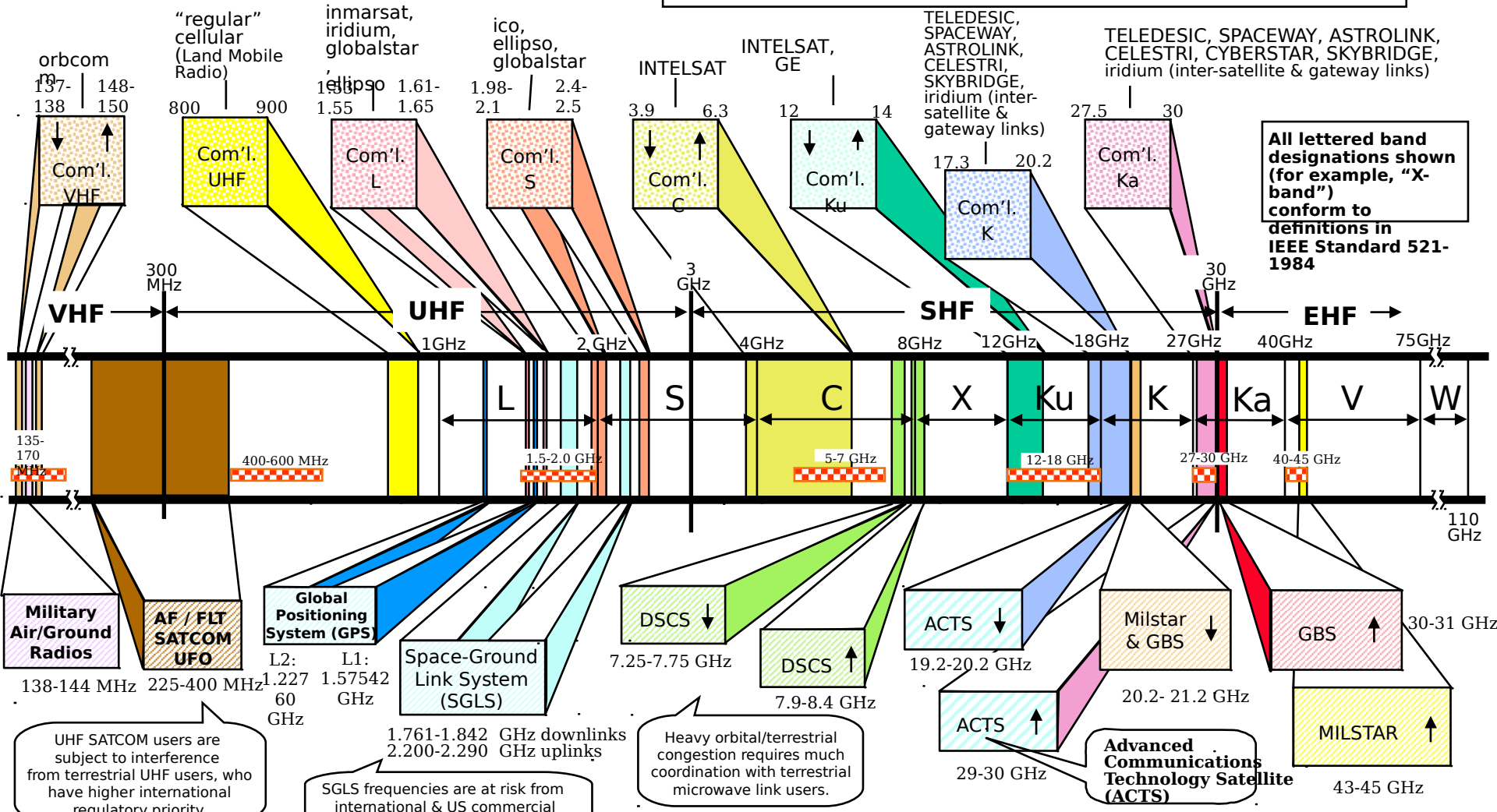
Communications

Satellite Communications Frequency Usage

Commercial SATCOM Services

LEGEND: (Commercial SATCOM)

CAPITALIZED NAMES = **F**ixed **S**atellite **S**ervice (**FSS**)
lower case names = **M**obile **S**atellite **S**ervice (**MSS**)/**P**ersonal **C**omm **S**ervices (**PCS**)



Government / Military SATCOM Services

↑ Band = Used as Uplinking Band

= 'At-Risk' bands currently sought for commercial satellite use, with potential for U.S. or international spectrum reallocation

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Example SatCom Service Providers

Services	Messaging	Telephony	Broadband
Operational	**Little LEO** - Orbcomm **GEO** - American Mobile - Qualcomm	**Big LEO** - Iridium - Globalstar **GEO** - Inmarsat - Thuraya - Garuda	**Ku-band** - Cyberstar - Others KA –Band C-Band - intelsat
Emerging	**Little LEO** - E-Sat - Final Analysis - Leo One	**Big LEO** - ICO - Others	**Broadband LEO** **Ku-band** - Skybridge **Ka-band** - Teledesic **Broadband GEO** **Ka-band** - Spaceway - Astrolink - Cyberstar

Commercial Comm. Satellites

- 2 Primary Types
  - Narrowband
    - Low Earth Orbit (LEOs)
      - Little LEOs
      - Big LEOs
    - Geosynchronous Equatorial Orbit (GEO)
  - Wideband
    - Broadband LEOs
    - KU/KA GEOs
    - C Band GEOs

Little LEOs

35 satellites

48 satellites (Terminated)

26 satellites (Terminated)

- Defining Characteristics
  - Low-data-rates
  - Short transmissions
  - Examples:
    - Paging Systems
    - Vehicle Tracking Systems

BIG LEOs

93 satellites, 11 Failed

48 satellites

- Defining Characteristics
  - Medium data rate
  - Voice data
  - Data in real-time

DoD use of Iridium

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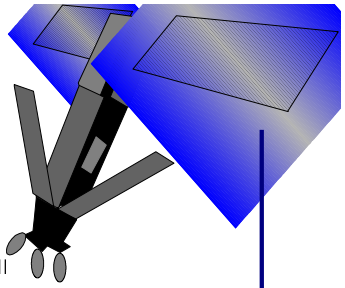
Motorola / Iridium Consortium



Constellation:
- A. Inorbit: 66
- B. Spares: 7

Primary Coverage (LAT):90N-90S
Primary Coverage (LON): All

No. of Earth Stations: 15 - 25
(no ES required if Iridium to Iridiu

Service Date IOC / FOC: 4Q 1998 / 4Q 1998

Distinguishing Characteristics

Polar Coverage
On Board Processing
Inter-satellite Crosslinks
- - comms do not require gateway, billing does
2nd Generation handheld Terminal
DoD pays monthly fee- 3m per month
- Government Gateway- Wahiawa, HI
- No noticeable delay in transmission

Capacity / Satellite (No. Simultaneous Users): 3,840
(250 simultaneous users per beam)

Frequency Band, Sat - User, Mhz 1616 - 1626.5 (L)
User - Sat, Mhz 1616 - 1626.5 (L)

Crosslink Capability: Yes

Orbit Type: LEO

Orbit Shape: Circular (Polar, 86.4 deg incl)

Modulation: TDMA

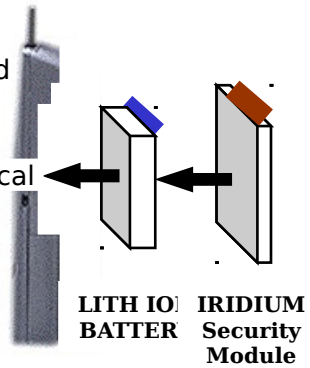
Space Segment cost ($M): 3,759

User Terminal Types Supported: Hand Held
Mobile
Fixed Site
Aeronautical
Pager

User Data rates (kbps): 2.4, 9.6
Voice and Data

Handset Cost (est): $4100

End-User Tariff, $ per Minute: **$0.00**



mss_bfrg.pre0

- Resurected on November 15, 2000

Source: Naval Space Command

Wideband GEOs

- Defining Characteristics:
  - Video data
  - Large data transfer
  - Large number of channels
  - Slight delay in voice transmission

Commercial GEO Communication Satellites

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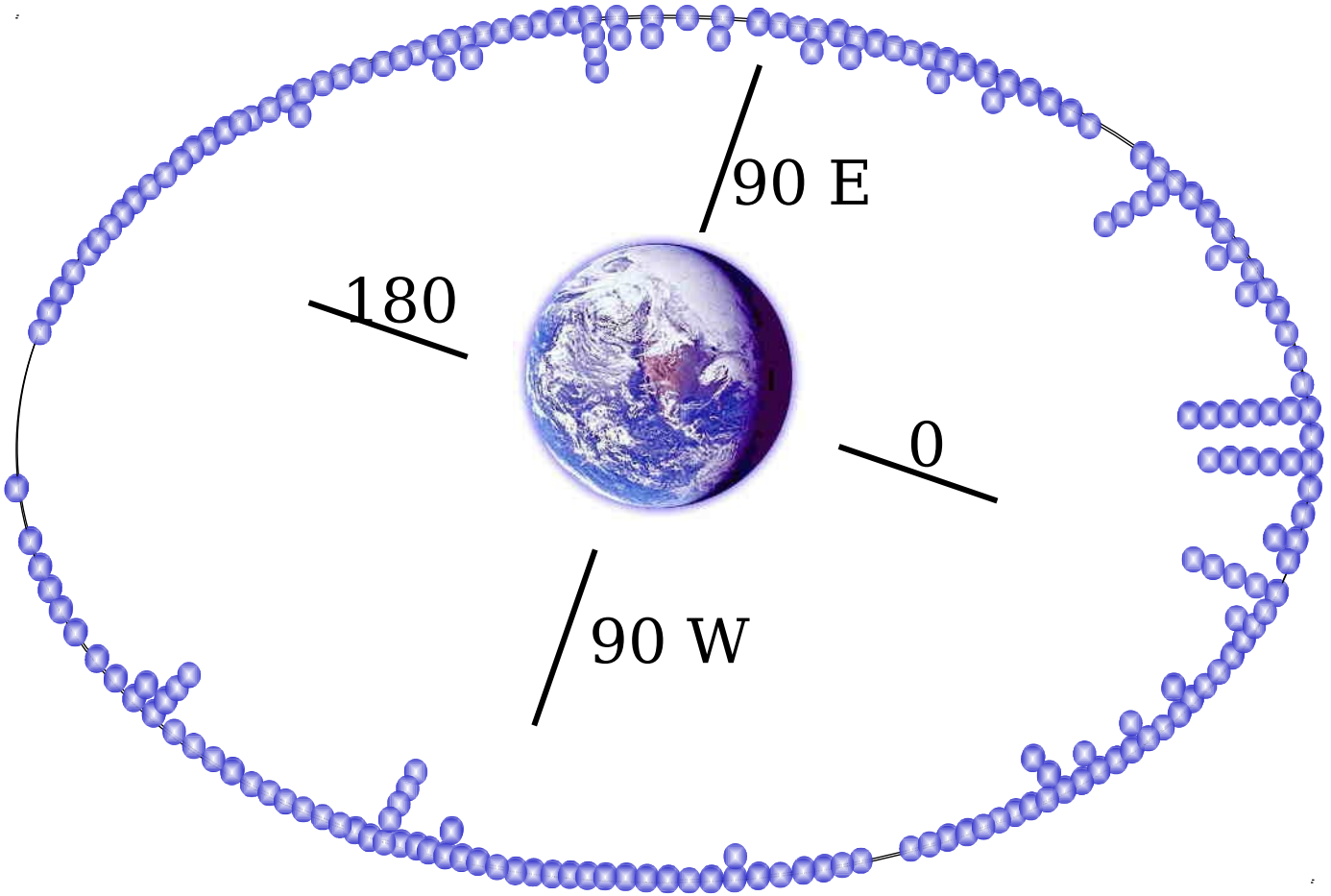

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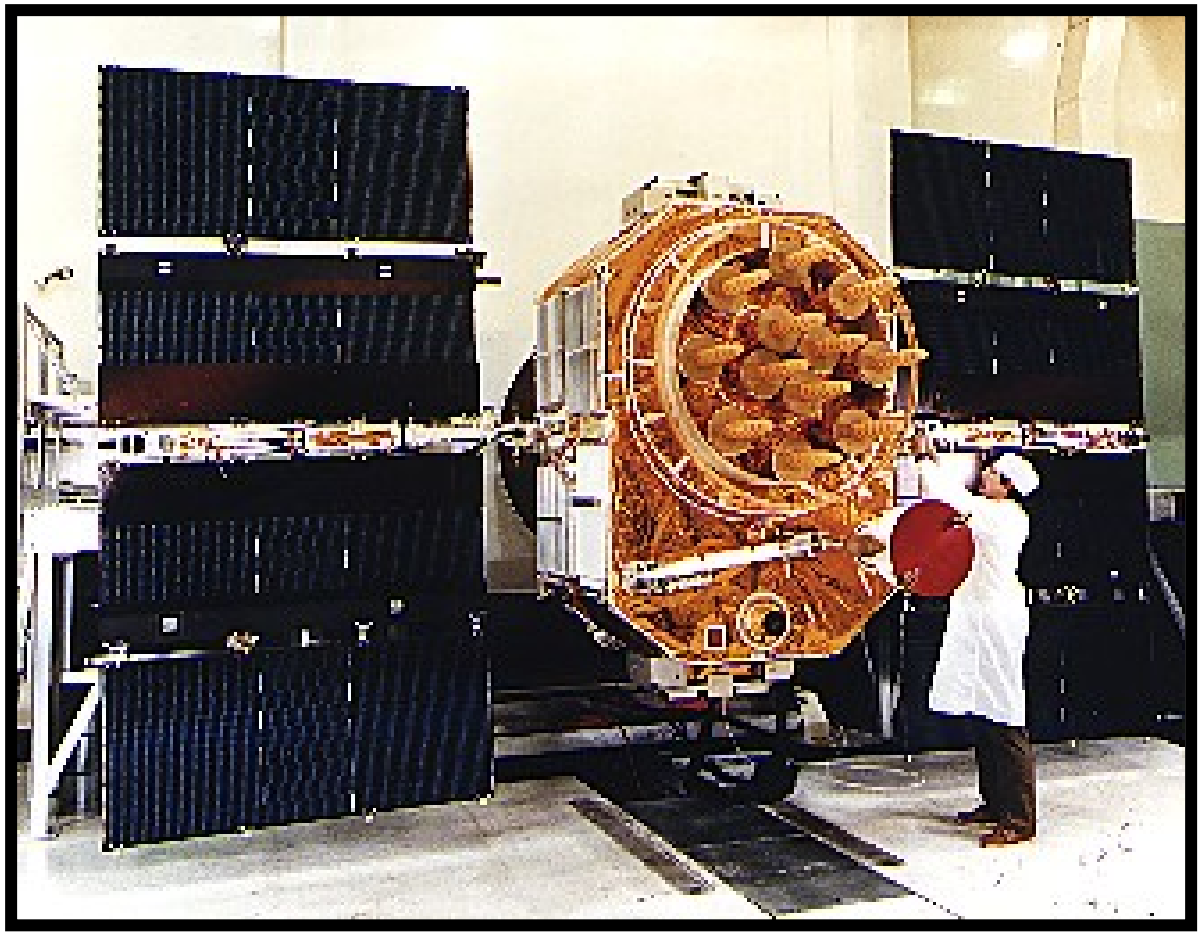
Commercial Navigation



Commercial Navigation

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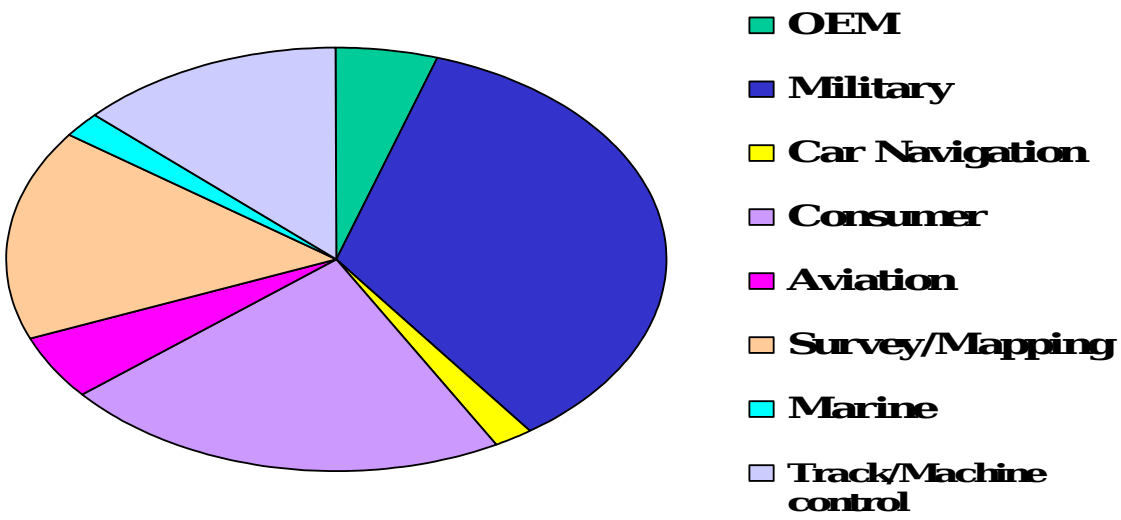
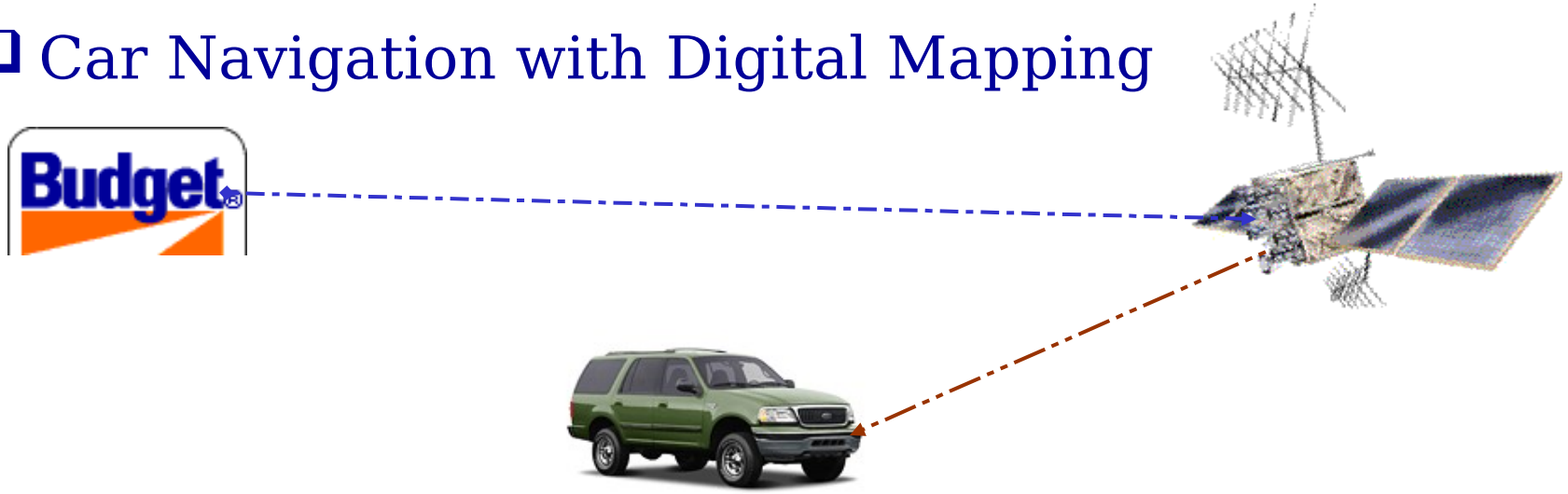
- Military is only one of many GPS users



- President has committed U.S. to provide global coverage for world-wide use
- Current unit costs as low as $100, with prices up to $80,000 depending on features
- Multi-Billion dollar high-growth industry (~25%/year; ~$16B – 2003)

Commercial Navigation Market Description

- Car Navigation with Digital Mapping

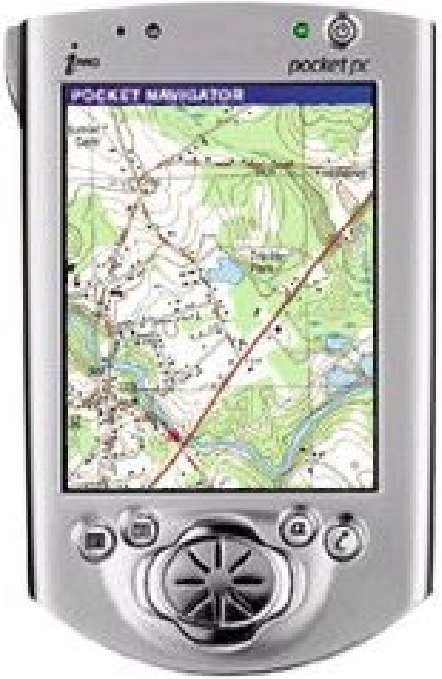


- Aeronautical Navigation
  - Full incorporation planned by FAA
  - Cost: $355-$60,000 per unit

- Marine Navigation (Replacing Loran)
  - Cost: $300-$60,000 per unit

Commercial Navigation Market Description

- Surveying/Map Making
  - Allows for more accuracy in positioning and measurements (accuracy within one centimeter)
  - Cost: $100 to $82,000 per unit



- Private Consumer Direct Market
  - Backpackers, Fishermen, Hunters
  - New applications still emerging
  - Cost: $100 and Up

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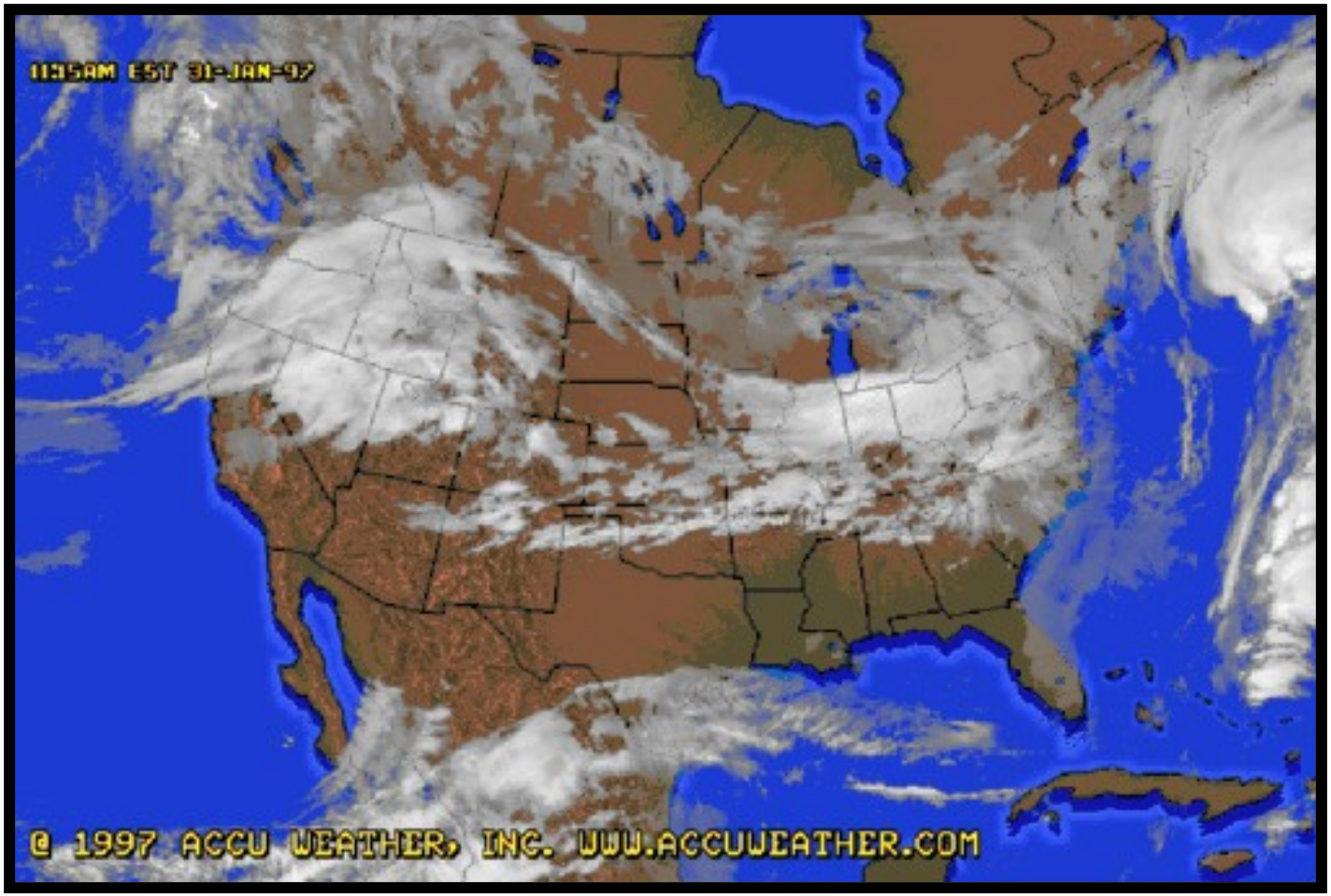
Remote Sensing and Ground Imaging Systems



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Types of RS Images

- Standard Camera Photography
  - Panchromatic Film (e.g. LANDSAT, SPIN)
- Electro-optical (E-O)
  - Similar to video-camera and FAX technology (e.g. SPOT)
- Synthetic Aperture Radar (SAR)
  - Detect surface features regardless of light or weather conditions (e.g. RADARSAT)
- Infrared Satellites
  - Primary source of weather data (e.g. DMSP, POES, GOES, NPOESS)
  - Intelligence (e.g. NRO)
- Multispectral/Hyperspectral
  - Allows determination of materials, gases, soil disruptions (Orbview 4/Warfighter-1)

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Traditional Applications of Remote Sensing Data

- Meteorology
  - Extensive use of satellite imaging to predict weather fronts and weather patterns
  - Typically can be viewed on every news broadcast
- Cartography
  - Traditional map-making
- Hydrology
  - Flood Basins

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New Consumer-Oriented Applications

- Insurance claims adjustment
  - E.g. flood and earthquake damage assessment
- Agricultural (GPS aided)
  - Areas of mineral depletion
  - Soil Samples
- Mining and natural resource extraction
- Real estate assessment
- Archaeology

Future Impact to Military Reconnaissance

- Capabilities are militarily useful
  - Commercial satellites resolution - 1m or better
    - NOAA recently approved Space Imaging and DigitalGlobe for .5 meter resolution
  - "Checkbook shutter control" of 1 m imagery over Afghanistan
    - US Government bought up all imagery over Afghanistan to deny its use to adversaries
- Data available to anyone on an as needed basis
  - Images available for as little as $10/ KM
  - Available to foreign governments without their own reconnaissance systems

The Pentagon - December 28, 2000 - IKONOS 1-mete

The Pentagon - September 12, 2001 - IKONOS 1-mete

SPACE IMAGING

- Manhattan New York- June 30, 2000 & September 15, 2001 - IKONOS 1-meter

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Commercial Space Opportunities

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Commercial Space Opportunities

- DOD space program growth remains constant
  - Commercial growth increases in SatCom
- Commercial market is driving new architectures, technologies, and processes for several space app's
- Over $54 Billion per year space industry and growing
- Opportunities to leverage off Commercial Systems
- Growing source of innovation in space architectures, manufacturing, acquisition, efficiency, . . .

What's the catch?

Adversary Uses of Commercial Space

- Same benefits as Do

- Reduced Cost
  - Paying for Services, not Develop

- Increased Capabilities
  - Allows Adversary to have near equivalent tech

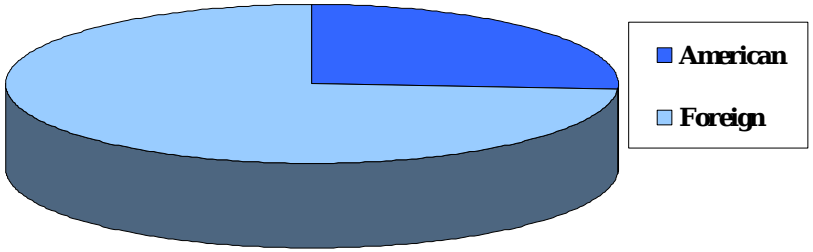
Vs.

  - Increased coverage

Impediments/Obstacles to Commercial Space Usage

- Rules of Engagement
  - Not clearly defined
  - National Policy

- Availability of GEO Payload



- Security
  - No LPI/LPD
  - Adversary using BFT for intellige
  - Data manipulated/monitored

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Schriever 2001 Space Wargame Commercial Play

- Both sides needed commercial space
  - RED aggressively bought up commercial capability for own use and as a means to deny BLUE
  - BLUE bought additional Satcom capacity
- BLUE and RED discovered they had little leverage over commercial cell
  - Commercial space answered to shareholders, bottom line, and contractual relationships

Commercial Space…a Force Multiplier, for ALL

Schriever 2001 Space Wargame Commercial Insights

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- Commercial Space answered to niether Blue or Red
  - Treat them as a commercial entity, NOT as a warfighter
  - US needs to establish clear ROEs with respect to commercial space
  - New Processes are needed to integrate commercial space into government policy and decision making
- Specific Desired results from engaging Commercial Space in time of war
  - Deny / Limit ADVERSARY's use of commercial space capabilities
  - Enhance ONE'S OWN use of commercial space capabilities
  - Avoid escalation into space against commercial assets
  - Minimize global economic ripple effect

"The commercial cell at our game was superior and the outbrief from the commercial Cell on final morning was a

“RocketCam”

Ecliptic Enterprises

Questions?